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DARPA Space Activities

Introduction

Space is ripe for revolution. The United States is the world leader in space, yet it's not at all clear we should stay the current course. Our presence in space is critical to national security today, yet a changing world demands we reflect carefully on our future course. We must reflect on new initiatives that make space more operationally responsive, support joint warfighting, and consider new operations in near-space.

Aircraft capabilities have soared from Kitty Hawk to the SR-71 and beyond. By comparison, the progress in space almost seems timid. We need some serious changes to how the nation utilizes space—not for the sake of change, but for the sake of relevance. The dilemma we face is not a lack of technology; we have more options now than ever. Instead, we face a desperate need for options that are clearly superior breakthroughs. This is DARPA's forte.

The cost of doing useful things in space is... astronomical. Why? Primarily because it is tough to get to space. Many of our systems, including the space shuttle, are in low Earth orbit, which is only a couple hundred miles up. How hard can it be to get there? It actually isn't terribly hard to get to 200 miles altitude; the problem is getting there with

orbital velocity. That takes 6 times the energy. Chemical launch just barely gets us to space. Only a few percent of a rocket's weight makes it into orbit as payload. If the Earth were 50 percent larger in diameter, we couldn't get to space with chemical energy. We're very nearly trapped here on Earth.

During the Cold War, the high cost of space was clearly worth it. It allowed us to see into the Soviet Union often and with impunity. Space helped

stabilize a precarious world. Space allowed us to communicate with our fleets and ground forces with much improved fidelity and reliability, and it eventually allowed us to navigate with unimaginable precision. Some even say our strategic defense initiative

efforts played a large role in the fall of the Soviet Union.

Space remains critically important to both military and civilian functions. It underpins our nation's security and it significantly enhances our quality of life. It is undeniable that our overwhelming dominance on land, sea and air is tied to space. As a result, we are faced with serious questions: How do we ensure our military superiority as the barriers to space access decrease? How do we prepare for the next quarter century when those intent on



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harming us are not easily found from the distance of space? Do we lessen our dependence on space, or do we strengthen our capabilities there and strongly defend them? Can we afford both? Can we afford not to succeed at both? These are exceedingly difficult questions whose answers, in any case, will involve investment that demands serious and careful consideration of the options, and sooner is better than later.

Let's consider the ground rules (or is that the space rules?) before moving on to what we're doing at DARPA. High resolution is important to surveillance and the distance of space requires huge apertures for high-resolution imaging, and launch vehicles for such satellites are extremely expensive, with long lead times. Both of these make our satellites hugely expensive, often exceeding a billion dollars. This means we can't afford failures, which means we build in a lot of redundancy, which causes us to keep records on every part that's used, which causes us to test satellites for months and month, which drives the cost even higher, which makes us even more risk averse, which drives the cost even higher, which makes us even more risk averse. It's a vicious cycle.

DARPA's Space Activities are focused on breaking out of this dilemma. We're working hard to resist the gravitational-pull of self-evident truths fueled by a trillion-dollar Cold War legacy. As usual, we start with more questions than answers:

- What new advantages can space bring against the daunting threats of today's terrorists?
- What are the "rules of the sea" for space?
- How do we protect our fleet?
- What role will commercialization play?
- Can space tourism become an engine for growth?
- How do we retain our global advantage in space?

The time is ripe for revolution. What if we could launch many small microsatellites and network

them with WiFi, the way we link laptops to the web at Starbucks? What if we could develop a launch vehicle so light and reusable that we could move from limited launches to space sorties? What if we could develop antennas that are small on launch, enormous on orbit? Or apertures that build themselves in space? What if we could exploit near space to take advantage of the closer distances and eliminate orbital launch requirements altogether? What if, in the quest to monitor weapons of mass destruction (WMDs), we could sprinkle large geographic areas with dust that changes in the presence of WMD agents and monitor all this from space?

DARPA's space efforts are all about making architectural leaps, liberating our minds and missions from the conventional wisdoms of the past. As we ask these questions though, we need to recognize that there are still some clear truths as well. We know that space-based navigation, communications and weather assessment are, and will remain, critical to US military strength. We know that space is attracting increased global participation. We see private enterprise successfully entering the space launch scene and we wish them well. We see overhead imagery growing in commercial importance, just as GPS has blossomed into an indispensable business enabler. And we know one more thing: There are growing alternatives to space for critical functions like intelligence, surveillance, and reconnaissance. There are other domains, other dimensions that offer opportunities to solve the challenges we face. The economic utility of space imaging and data collection for military needs must be weighed against other alternatives, like near-space, or airborne or ground-based collection, or most likely a combination of space and the others.

These trends add up to the situation where space is today: wide open for innovation. Recognizing the potential of new ways to utilize space, DARPA's space program has grown forty-fold in four years, to \$400 million this year!

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We're pursuing several general thrusts:

- “Operationalizing” space with responsive launch, support, and payloads
- Bringing Joint warfighting to space
- Tapping the benefits of space for all Military Services
- Exploiting the potential of near-space, to provide new options for access, infrastructure and operations

Our job is to address these priorities, but not just that. Our job is to see the revolutions beyond these imperatives as well.

In our view, today's challenges in space can't be mastered by improvement at the margins. We need quantum improvements in key capabilities. We need 90 percent reductions in launch costs, not 10 percent reductions. We need power sources that deliver 10 times more power than our conventional solar arrays. We need ten-fold reductions in the size and weight of our key satellite systems. Getting quantum improvements means asking tough questions, some pretty big “What if?” questions. The wonderful thing about DARPA's space technology programs is that we are asking those questions and executing the answers.